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# Study of economically important traits to give an insight into the character association and their contribution in yield of sesame (*Sesamum indicum* L.) genotypes

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This study was conducted during the year 2018 and 2019 in the Oilseeds Research Institute, AARI, Faisalabad, Pakistan, to assess trait association among 30 sesame genotypes. Analysis of variance, correlation analysis and path coefficient analysis were deduced from the acquired data. Analysis of variance presented that all characters were very different from each other. The detail examination of two years combined data showed that at genotypic as well as phenotypic level (PH) height of plant, (NCP) No. of capsule per plant, (NBP) No. of branches per plant and (1000SW) 1000 seed weight illustrated substantial positive correlation with SY. DF50 and days to maturity showed negative and substantial contribution to Seed Yield (SY). Furthermore, path analysis, utilizing grain yield as a reliant variable disclosed that PH imparts positive direct effect on SY, followed by 1000SW, NBP and NCP but these characters (1000SW, NBP and NCP) had a lower direct impact on seed yield (SY). DF50 had the maximum negative direct effect on seed yield and DM also indicated negative direct effect on SY. In path analysis, similar effective indirect effect was detected for (PH) height of plant via (NBP) No. of branches per plant and (NCP) No. of capsule/plant. (NCP) No. of capsule/plant with (NBP) No. of branches/plant displayed the greatest indirect effect on SY. Similarly, for (NBP) No. of branches/plant, (NCP) No. of capsule /plant showed significant positive indirect effect on (SY) Seed yield. (1000SW) thousand seed weight had high indirect effect of (NCP) No. of capsules/plant on (SY) seed yield plant.

**Keywords:** Correlation, yield attributes, genetic variability, oilseed crop.

## INTRODUCTION

Efficient crop breeding and improvement are the most important processes to ensure that each yield-related property contributes to yield and choose ingredients that maximize yield for all crop plants will also help to determine model plant type of species. Sesame (*Sesamum indicum* L.) is considered as an important oilseed crop. Owing to have handsome oil contents (38-54%), it is described as the queen of oil crops. Moreover, having high quality oil, antioxidants and proteins, it has immense therapeutic uses as well (Erbas *et al.*, 2009). In addition to confectionary purposes and unprocessed food, sesame seeds are used in sweets and bakery products, and also used in making of soaps, perfumes, vegetable oil and carbon paper as well (Khan *et al.*, 2001). It is widely preferred due to its agricultural characteristics like its growth can occur without irrigation or rainfall in low soil moisture. It grows well in tropical and subtropical climates (Ashri, 2007). In 2020, an area of 351.189 thousand acres of Pakistan generated 84.285 thousand tons of sesame seeds (Agricultural Statistics of Pakistan, 2020). Pakistan generated revenue of Rs.14131 million by of sesame seeds in 2020-21(Federal Bureau of Statistics 2020-21). To maintain the revenue, we need to close the gap between demand and production. Low seed yield of sesame is one of the prime reasons why sesame breeding is required (Furat and Uzun, 2010). The process of breeding sesame yield is not easy, because yield is a complex phenomenon as several contributing traits that are influenced by the surrounding environment(Rauf *et al.*, 2004). Additionally, yield components possess complex characteristics as these are the conclusions of multiplicative interactions among the several components of yield, and they rely on many morphological properties, most of which are quantitatively inherited and are

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strongly influenced together (Bidgoli *et al.*, 2006). In order to improve yield traits which have a huge impact on grain yield, it is fundamental to study the input of each trait (Tuncturk and Ciftci, 2007).

Understanding relationships among the yield and its components is important in the process of selection, which could be studied through path coefficient analysis and characteristic associations (correlation)factor. Knowledge of the correlation between grain yield and other characteristics will help in choosing the right plant type. So, the degree of association between two traits is determined by correlation (Qamar *et al.*, 2021). In addition, path coefficient analysis can separate indirect and direct effects, resulting in standardized regression coefficients and effective selection (Sumathi *et al.*, 2007). Furthermore, importance of genetics and phenotype diversity, character association and heritability has been proven by several scientists (Saini and Sharma, 1995; Lekh *et al.*, 1998) for additional upgrading of gene.

Therefore, this study aimed not only to improve agronomic performance and serve as the basis for the selection of sesame improvement, but also to evaluate the interrelationship and contribution of some growth characteristics to seed yield.

## MATERIALS AND METHODS

30 accessions of sesame were sown on June 22, 2018 and June 24, 2019. Hand weeding and irrigation were performed when needed. Flowering was first observed on July 20-23, respectively, during the growth period of 2018 and 2019 respectively. Formation of capsule was observed between July 31 and August 3 for the two successive years. The harvesting process began in early October. A two-year experiment showed a similar trend in temperature and observed the topmost temperature during June, July &August and at the lowest temperatures in October. Humidity was generally similar to the growth period in 2018 and 2019, and the results were very suitable for the constant averages. Randomized Complete Block Design was utilized for conducting the experiment in 03 replications. For each entry per replication, 3 rows of 5 meters in length were used. Row to Row distance was 45cm. At sowing, the recommended dose of fertilizers were applied.

**Table 1. List of sesame accessions used in research**

| Sr. | Accessions | Sr. | Accessions | Sr. | Accessions |
|---|---|---|---|---|---|
| **1** | 17001 | **11** | 87005 | **21** | 40009 |
| **2** | 17002 | **12** | 50007 | **22** | 50009 |
| **3** | 17003 | **13** | 86003 | **23** | 50022 |
| **4** | 17004 | **14** | 70002 | **24** | 40004 |
| **5** | 17005 | **15** | 70005 | **25** | 10003 |
| **6** | 17006 | **16** | 16001 | **26** | Black Till |
| **7** | 16002 | **17** | 86001 | **27** | 50011 |
| **8** | 16003 | **18** | 87006 | **28** | 16001 |
| **9** | Small Pod | **19** | ML-6-8/12 | **29** | TH-6 |
| **10** | 16005 | **20** | 77011 | **30** | TS-5(C) |

The Sesame descriptors described by NBPGR and IPGRI (2004) were utilized for quantitative observations recording; (DF50) fifty percent flowering date, (PH) height of plant, (NB) No. of branches, (NCP) No. of capsules/plant, (1000SW) 1000 seed weight and (SY) seed or grain yield. Similarly, seed yield (g) per row for each genotype was noted and was then changed into kg/ha. The weight of the thousand seeds was calculated by measuring the weight of 200 species. Analysis of variance was completed on the average value of the varieties being checked in all blocks. No noteworthy replication effect was observed for 2 experimental years, so the average value for the two years was calculated and was utilized for the analysis (Gupta *et al.*, 2009). The formula proposed by Kwon and Torrie (1964) was utilized for performing correlation coefficients. The concept of path analysis was utilized for revealing direct and indirect effects on the yield in accordance with the method proposed by Dewey and Lu (1959). Moreover, in multivariable systems, path coefficient analysis relationships amongst variables are considered. Therefore, in this study, path coefficient analysis was performed by utilizing yield of seed per plant (g) as a reliant variable and additional detected characteristics as free variables.

## RESULT AND DISCUSSIONS

The data presented in Fig. 1 and Fig. 2 showed the maximum, minimum and mean temperature during the growing season 2018 and 2019 respectivelyof Sesame in Faisalabad, Pakistan. The temperature was high during germination and seedling stages and gradually decreased at vegetative growth stages and flowering stages.

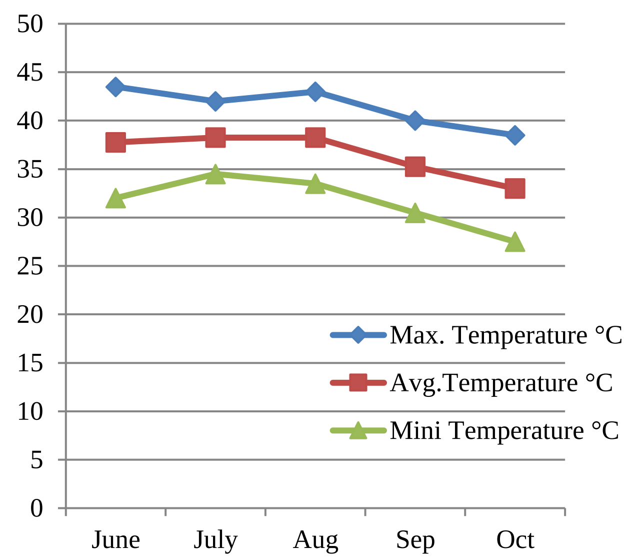



**Figure 1. Data for temperature during crop growing period 2018.**

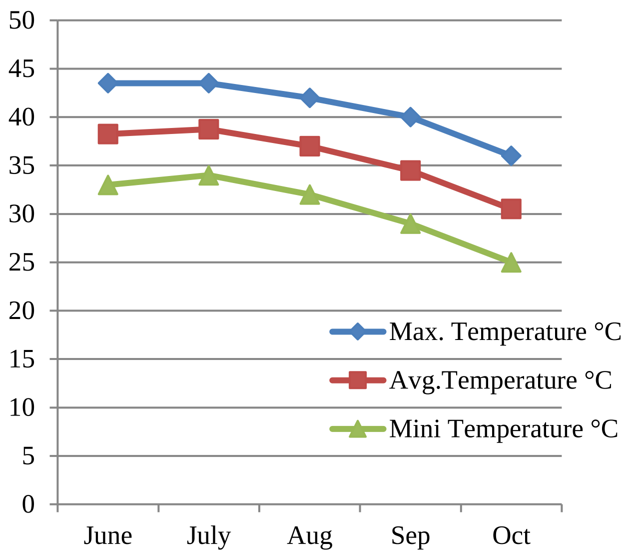



**Figure 2. Data for temperature during crop growing period 2019.**

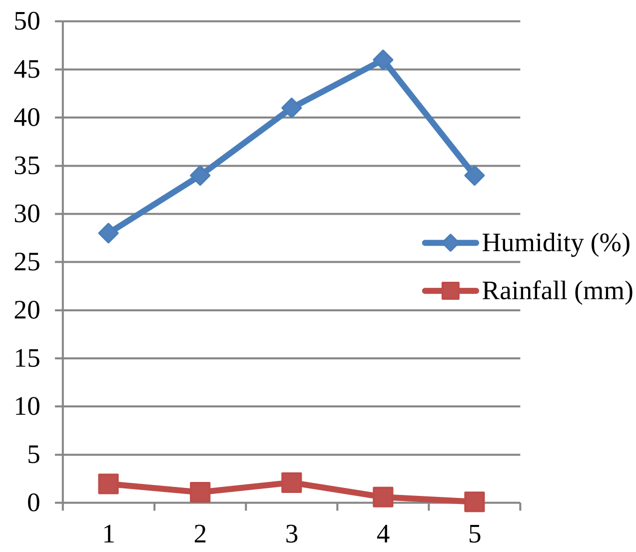



**Figure 4. Data for Rainfall and Humidity during crop growing period 2019.**

The data presented in Figure 3 and Figure 4 showed rainfall and humidity during the growing period 2018 and 2019 respectively of crop. The data shows there was no rainfall during vegetative growth stage to maturity stage in 2018 but in 2019 at vegetative stage maximum rainfall was 2.1 mm.

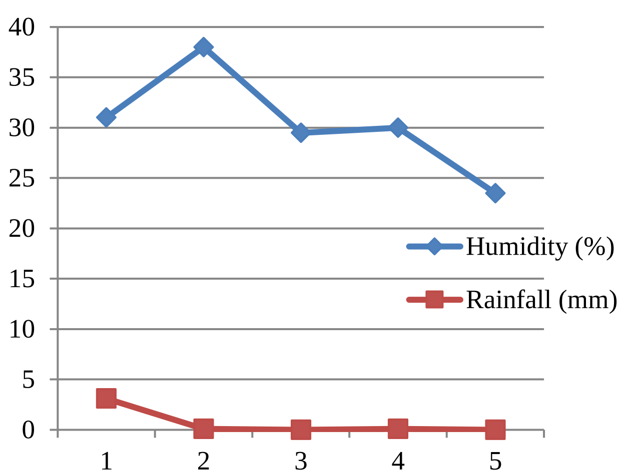



**Figure 3. Data for Rainfall and Humidity during crop growing period 2018**

Variation is the prerequisite to improve any breeding program with the development of new hybrids and varieties. ANOVA of different characters is presented in Table 2.

Figure 5 shows the yield related parameters in each genotype. The results showed that all the 30 genotypes had significantly different genetic makeup from each other. Maximum plant height was observed in 70005 (208 cm) and minimum value of plant height was observed in 16001(143 cm). The 86003 showed the best performance regarding seed yield (2413kg/ha) among all the genotypes having maximum number of pod per plant (76 pod per plant), number of branch per pant (6) and 1000 SW (4.43g) and mature in 85 days.

Figure 6shows the mean seed yield comparison between the sesame genotypes. Differences in the seed yield showed in Figure 6 proved that all the genotypes had different genetic material because all the agronomic and cultural practices were same throughout the growing season. Four genotypes 86003, 17006, 17003 and 87005 were significantly produced higher seed yield (2413kg/ha), (2101kg/ha), (2084kg/ha) & (2077kg/ha) respectively than the check variety TS-5. Fazal *et al.*, 2015 used same check variety in their experiment and found similar results.

Table 3 shows the correlation coefficients for grain yield and yield related components. It was observed that days to 50

**Table 2. Mean squares of sesame accessions for various plant characters.**

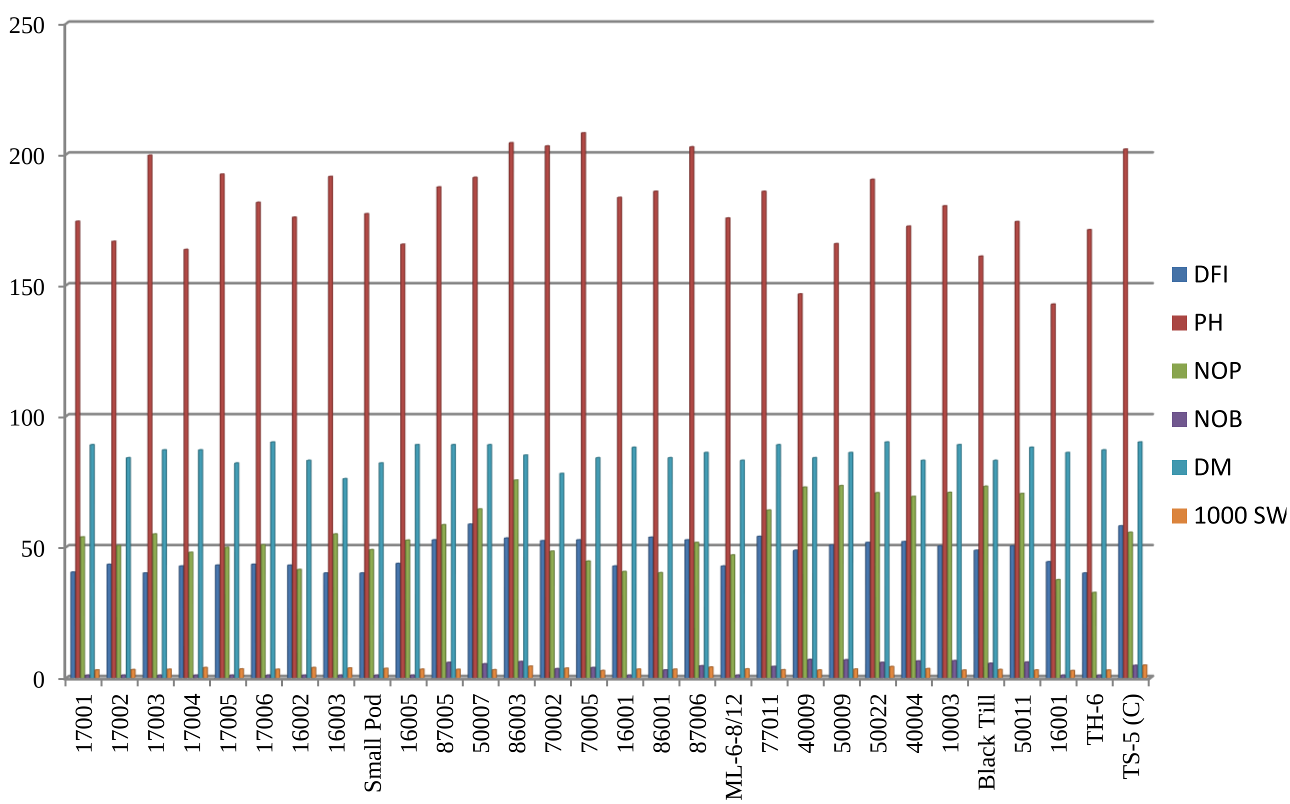
| SOV | DF | DF50 | DM | PH | NBP | NCP | 1000SW | SY |
|---|---|---|---|---|---|---|---|---|
| **Accessions** | 29 | 84.52** | 41.52** | 861.58** | 19.79** | 807.92** | 0.132 | 588012** |
| **Replication** | 2 | 0.70 | 34.14 | 48.61 | 0.71 | 769.03 | 0.348 | 554 |
| **Error** | 58 | 0.24 | 14.51 | 148.14 | 0.38 | 289.09 | 0.109 | 267 |

**DF=** Degree of Freedom, **DF50=** Days to 50% flowering, **DM=** days to Maturity, **PH** =Height of plant, **NBP** = No. of branches/plant, **NCP** = No. of capsules/plant, **1000SW=** thousand Seeds weight, **SY=** Seed **or** grain Yield.

**Table 3. Correlations for different traits in sesame at genotypic and phenotypic level .**

| | DM | PH | NBP | NCP | 1000SW | SY |
|---|---|---|---|---|---|---|
| **DF50** | **0.7669**** | **0.1240** | **0.2107**** | **0.0104** | **0.1685*** | **-0.4013**** |
| | 0.7121** | 0.1020 | 0.1828** | 0.0353 | 0.1605* | -0.2586** |
| **DM** | | **0.3265** | **0.2843**** | **0.0776** | **0.5016**** | **-0.5031**** |
| | | 0.2311 | 0.2140** | 0.0984 | 0.2867** | -0.2086** |
| **PH** | | | **0.7530**** | **0.5690**** | **-0.0200** | **0.3640*** |
| | | | 0.7490** | 0.5650** | -0.0180 | 0.3550* |
| **NBP** | | | | **0.6020**** | **0.0270** | **0.4540**** |
| | | | | 0.5480** | 0.0430 | 0.4090** |
| **NCP** | | | | | **0.5740**** | **0.8200**** |
| | | | | | 0.4840** | 0.9060** |
| **1000SW** | | | | | | **0.7710**** |
| | | | | | | 0.7470** |

** = highly significant bold value= Genotypic correlation bold font Value = Phenotypic correlation normal font value **DF50 =** Days to 50% flowering, **DM =** days to Maturity, **PH** = Height of plant, **NBP** = No. of branches/plant, **NCP** = No. of capsules/plant, **1000SW =** thousand Seeds weight, **SY =** Seed **or** grain Yield.




percent flowering had noteworthy (+) association with (DM) days to maturity (Genotypic: 0.7669, Phenotypic: 0.7121), (NBP) No. of branches per plant (Genotypic: 0.2107, Phenotypic: 0.1828) and (1000SW) 1000 seed weight (Genotypic:0.1685, Phenotypic:0.1605) and non-significant positive association with (PH) plant height (Genotypic: 0.124, Phenotypic: 0.102), (NCP) No. of capsules per plant (Genotypic: 0.0104, Phenotypic: 0.0353). Maturity days showed a significant amount of positive association with (NBP) number of branches per plant(Genotypic: 0.2843, Phenotypic: 0.2140) and (1000 SW) 1000 seed weight (Genotypic: 0.5016, Phenotypic: 0.2867) (Sopundharrya *et al.*, 2017).

Plant height exhibited the (+) correlation at both genotypic and phenotypic levels with capsules per plant (Genotypic:0.569, Phenotypic:0.565) and branches per plant

(Genotypic: 0.753, Phenotypic: 0.749), while non-significant and (-) correlations with 1000-seed weight at both genotype and phenotype levels (Genotypic: -0.020, Phenotypic: -0.018).According to the critical analysis of Table 2, the capsules per plant showed a very vital amount of genotype and phenotypic correlations with branches per plant (Genotypic: 0.602, Phenotypic:0.548)and 1000 seed weight (Genotypic: 0.574, Phenotypic:0.484). Though, branches/plant impart (+) correlation with thousand grain weight at the genotypic level (0.027). A detailed study of two years of collective data showed that genotype, as well as phenotype levels(NBP) branches per plant, (PH) height of plant, (NCP) capsules per plant, and 1000SW showed the significant (+) correlation with SY.Similar results are in accordance with the results of Sumathi *et al.* (2007); Sumathi and Muralidharan (2010); Yol *et al.* (2010), ); Goudappagoudra *et al.*(2011); Akbar *et al.* (2011), Vanishree *et al.* (2011); Thirumala *et al.* (2013) and Vanishree *et al.* (2013).

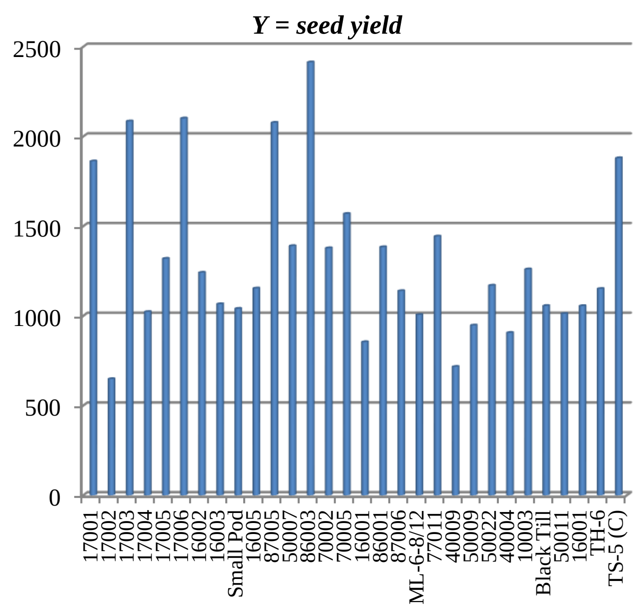



**Figure 6. Mean comparisons of sesame accessions for seed yield.**

DF50 negatively contributed to SY (Genotypic: -0.4013, Phenotypic: -0.2586). This trait is extremely related with the days to maturity mainly due to early flower blooming in sesame which aids early capsule formation. In this study, days to maturity also showed negative effects on the yield of seed (Genotypic: -0.5031, Phenotypic: -0.2086), while same results were also accomplished by Gnanasekaran *et al.* (2008).

Thus, this path coefficient analysis offers a further reliable depiction of the association, by describing not only the direct effects but also the indirect effects of the variables through the partition of correlation coefficients (Ali *et al.*, 2009). Therefore, path coefficient analysis can be utilized for the estimation of relative importance of each character. This is because it gives a clear idea of which characters contribute the most to seed yield. The direct and indirect effect values for path analysis are presented in Table 4. Moreover, collective data showed that PH positively affects SY. This is consistent with the findings of Yingzhong and Yishou 2002. Following this character was 1000SW, NBP and NCP, but these traits had a low direct impact on SY. Days to fifty percent flowering had the greatest negative effect on grain yield (SY) (-0.328), and DM showed a direct effect on SY (-0.2315). Similarly, in the correlation coefficient, these characters possess a negative correlation with SY. PH makes the largest contribution to seed yield in sesame seeds due to its indeterminate growth habit (Uzun and Cagirgan, 2009). PH provides everlasting branching and capsule production. Therefore, PH, NBP (Gnanasekaran *et al.*, 2008 and Kumar and Vivekanandan 2009), NCP (Goudappagoudra *et al.*, 2011; Thirumala *et al.*, 2013 and Vanishree *et al.*, 2013) and 1000SW (Goudappagoudra *et al.*, 2011; Vanishree *et al.*, 2011 and Ibrahim and Khidir 2012) characters ought to be considered for gaining higher grain yield (SY) and was estimated together in sesame breeding program because it illustrated positive direct effect on grain yield. As expected, the correlation coefficients showed a positive relationship between these characteristics (Table 2). Therefore, these outcomes suggest that improved seed yield of sesame seeds is related to these traits and that the selection of these properties may have a positive influence on the yield of seed.

**Table 4. Direct and indirect effects of different plant traits on grain yield/plant.**

| | Indirect effect | | | | | | |
|---|---|---|---|---|---|---|---|
| | **DF50** | **DM** | **PH** | **NBP** | **NCP** | **1000SW** | **Direct effect** |
| **DF50** | | -0.4718 | -0.0180 | 0.0110 | -0.0410 | -0.0580 | -0.3280 |
| **DM** | 0.0535 | | 0.0491 | -0.0512 | -0.0089 | 0.0076 | -0.2315 |
| **PH** | 0.0105 | -0.2067 | | 0.0525 | 0.4310 | -0.0041 | 0.5300 |
| **NBP** | 0.0190 | -0.1878 | -0.0721 | | 0.4508 | 0.0143 | 0.0799 |
| **NCP** | 0.0010 | -0.0343 | -0.0500 | 0.0490 | | 0.1930 | 0.0492 |
| **1000SW** | 0.0152 | -0.2657 | 0.0011 | 0.0028 | 0.3107 | | 0.3787 |

**PH** = Height of plant, **NBP** = No. of branches per plant, **NCP** = No. of capsules per plant, **1000SW =** 1000 Seeds weight, **SY =** Seed or grain Yield.

Moreover, same effective indirect effects for path analysis were observed for (PH) height of plant via (NBP) No. of branches/plant and (NCP) No. of capsule/plant.(NCP) No. of capsule/plant with (NBP) No. of branches/plant showed the highest indirect effect on (SY) Seed yield (Sumathi *et al.*, 2007). Similarly, for (NBP) No. of branches per/plant, No. of capsule /plant (NCP) exhibited strong (+) indirect effect on (SY) seed yield. Therefore, this condition specified that although (NCP) number of capsule/plant didn't have a great direct impact on SY, and these traits had a strong indirect effect on height of plant (PH) and number of branches per plant (NBP), therefore, they might be evaluated along with selection studies. (1000SW) thousand seed weight had strong indirect effect of(NCP) number of capsules/plant on (SY) seed yield/plant.

***Conclusion*:** Analysis of variance presented that all characters were very different from each other which is the prerequisite to improve any breeding program with the development of new cultivars. (PH) height of plant, (NBP) No. of branches per plant and (1000SW) 1000 seed weight illustrated substantial positive correlation with SY at genotypic as well as phenotypic scale. Furthermore, path analysis, utilizing grain yield as a reliant variable disclosed that PH imparts positive direct effect on SY, followed by 1000SW, NBP and NCP but these characters (1000SW, NBP and NCP) had a lower direct impact on seed yield (SY). DF50 had the maximum negative direct effect on seed yield and DM also indicated negative direct effect on SY. After these findings it is recommended that these traits may be used as criteriafor the development of sesame verities with better yield.

***Author's contribution statement*:** Ghias M, Rauf S: Designed and conducted the study; Mustafa HSB, Hassan E: Supervised the study; Ghias M, Qamar H: Statistically analyzed the data; Qamar R, Rauf S: Formatted and finalized the manuscript.

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***Code Availability*:** Not applicable

***Consent to participate*:** All authors are participating in this research study.

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